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INSTRUCTION MANUAL

1251WP

California INSTRUMENTS

Invertron® AC POWER EQUIPMENT

California Instruments Corporation

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California INSTRUMENTS

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INSTRUCTION MANUAL

1251WP

Invertron®

1251 WP
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SECTION 1

INTRODUCTION AND SPECIFICATIONS

1.1 INTRODUCTION

This manual contains information on the operation, calibration and maintenance of the Model 1251WP.

1.2 GENERAL DESCRIPTION

The 1251WP unit is a light weight power source that will operate from any AC utility worldwide. Output is selectable for low range, 100V or 115V, operation, or high range, 220V, 230V or 240V, operation, at either 50 Hz or 60 Hz.

The universal nominal input can be from 100 to 240 volts at 50 or 60 Hz. Maximum operating range is 85 to 265 volt.

The maximum output power is 1250 VA - 11 amps at 115V or 5.5 amps at 230 volts. The voltage range is selected by the rear mounted selector switches. The output voltage and frequency can be incremented $\pm 10\%$ and ± 3 Hz respectively by the front panel push button switches.

An internal dip switch on the oscillator assembly allows the selection of 220V, 230V or 240V on the high range and 100V or 115V on the low range. One high range and one low range output voltage may be selected.

SPECIFICATIONS

ELECTRICAL

Input (115 VAC, 60 Hz, unless specified otherwise)

Nominal Line Voltage Range	100 - 240 VAC
Max Line Voltage Range	85 - 265 VAC
Max. Line Current (85V)	20A, Current harmonics per IEC 555-2
Line Frequency	45 - 63 Hz
Efficiency	≥75% (typical)
Power Factor	0.99
Line Inrush Current	≤30A
Hold-Up Time	10 ms (typically 20 ms)
Isolation Voltage (input-output)	2200 VAC
(input chassis)	1350 VAC

Output

*	Total Power	1250 VA RMS
	Load Power Factor	0 to unity
	Current	11A (115V), 5.5 (230V)
	Repetitive Peak Current	33A (115V), 16.5A (230V)
*	Voltage Range Low	100V or 115V
	High	220 VAC or 230 VAC or 240 VAC
	Limit Conditions	±10%
*	Total Harmonic Distortion	
	Bandwidth 30 kHz, Linear Load	≤2% (1% typical)
	Repetitive Peak Load	≤4%
	Output Noise (20 kHz to 1MHz) RMS	425 mV (115V) 850mV (230V)
	Voltage Accuracy	
	Line Regulation (10% line change)	
*	Load Regulation (Full load change)	≤2%
*	Frequency	50 Hz, 60 Hz
	Limit Conditions	±3 Hz (nominal)
	Accuracy	≤1%
	DC Offset Voltage	≤50 mV
	Isolation Voltage (output - chassis)	1350 VAC

*Denotes warranted specifications. All other specifications are supplemental.

"WARNING: Failure to use the equipment in a manner specified by California Instruments may impair the protection provided by the equipment."

Protection

Output Overcurrent ⊗⊗	Constant current mode 15% above rated current.
Output Short Circuit	Shutdown after approx. 5 secs. Cycle input power ON/OFF to reset.
Output Overvoltage	Shutdown, recycle input power to reset.
Input Overcurrent	Electronic Current Limit_wuse
Input Undervoltage	Protect, automatic recovery
Input Overvoltage/Transients	Protect, automatic recovery
Overtemperature	Shutdown, automatic recovery

Control

Front Panel Controls

	Control	Indicator	Resolution	Accuracy
Output ON/OFF	✓	✓		
OVERLOAD		✓		
100V		✓		1%
115V		✓		1%
220V		✓		1%
230V		✓		1%
240V		✓		1%
50 Hz		✓		1%
60 Hz		✓		1%
Voltage +10%	✓	✓	10%	1%
Nominal	✓	✓		1%
-10%	✓	✓	10%	1%
Frequency +3 Hz	✓	✓	3 Hz	1%
Nominal	✓	✓		1%
-3%	✓	✓	3 Hz	1%
Outputs Live		✓		

⊗⊗The Model 1251WP automatically reduces the output voltage until the full load current can be delivered without gross distortion.

The overload indicator is on during this condition. Automatic reset occurs when the load is reduced.

Rear Panel Controls

Voltage	High Range, Low Range
Frequency	50 Hz, 60 Hz

Internal Controls

Low Range Setting	110V or 115V
High Range Setting	220V, or 230V, or 240V

One low range value and one high range value only may be selected.

MECHANICAL

Dimensions	8.5" (216 mm) H, 8.75" (222mm) W, 18" (457 mm) D
Weight	30 lbs. (13.6 kg)
Air Intake/Exhaust	Sides/Rear
Connectors	
- Input	IEC 320 - C20
- Output	U.S. duplex (Nema 5-15P) European (Schuko CEE7/7, square face plate)

ENVIRONMENTAL/QUALITY

Operating Temperature	0°C to 40°C
Storage Temperature	-40° to +85°C
Operating Altitude	7500 ft.
Vibration	Transportation level
Shock	Transportation level
Quality Level	Commercial components

REGULATORY

Electromagnetic Emissions	CISPR 11
Acoustic Noise	Less than 60 dBA, 3 ft., no load to 50% load, 65 dBA full load
Safety	UL3111 listed and CUL CAN/CSA C22.2 No 1010.1-92 listed (both based on IEC 1010).

SECTION 2

INSTALLATION AND ACCEPTANCE

2.1 UNPACKING

Inspect the unit for any possible shipping damage immediately up receipt. If damage is evident, notify the carrier. DO NO return an instrument to the factory without prior approval. Do not destroy the packing container until the unit has been inspected for damage in shipment.

2.2 POWER REQUIREMENTS

The unit has been designed to work from any single phase utility supply. The IEC 320 input connector will accept a standard IEC line cord with the appropriate mating connector for the utility output. The utility output must be capable of supplying 1725 VA at between 100 to 240V in order to deliver full output power.

2.3 MECHANICAL

The 1251WP unit is a completely self contained portable unit. The cooling of the unit is accomplished by an internal fan that draws air in at the rear of the unit and expels it at the sides.

Both sides and rear of the unit must be kept free of obstructions and a 1" clearance from other equipment or structures should be maintained.

2.4 OUTPUT CONNECTIONS

When the low range is selected, only the duplex U.S. NEMA 5-15P output socket will be active.

If the high range is selected, only the European CEE7/7 socket will be active.

2.5 FUNCTION TEST

Ensure that the input power switch located on the rear panel is in the OFF position.

Select required output voltage and frequency by the position of the two slide switches on the back panel. NOTE: The input power should always be in the OFF position when the output range is changed.

Plug the unit into the AC power and turn the OFF/ON switch on the back of the unit to ON.

Enable the output by pressing the output ON/OFF switch on the front panel. The output "ON" light will be energized as well as one of the output voltage indicators and one of the frequency indicators. These indicators should correspond to the voltage and frequency selected. The neon lamp above the sockets will also be ON, showing power is present.

The push button switches on the front panel will select either $\pm 10\%$ output voltage and/or ± 3 Hz of the output frequency. The voltage and frequency deviation selected will be indicated by front panel LEDs.

SECTION 3

OPERATION

3.1 GENERAL

The input power ON/OFF switch and the OUTPUT VOLTAGE range switch and FREQUENCY switch are mounted on the rear panel. All other controls including the output ON/OFF switch are mounted on the front panel except for the actual individual output voltage selection which is determined by DIP switch selection inside the unit.

3.2 REAR PANEL CONTROLS

The ON/OFF switch mounted at the back of the unit interrupts both input power lines and removes all power from the unit. **The voltage selector on the rear of the unit selects either the high range of voltages (220V, 230V, 240V) or the low range of voltages (110V, 115V). These individual voltages are preset by the internal switches. (See internal controls later in this section). The frequency control switch selects either 50 Hz or 60 Hz output.

3.3 INTERNAL CONTROLS

An internal DIP switch located on the oscillator board at the front left hand side of the unit controls the HI and LOW range output voltages. Slide open small door to access switches.

CAUTION

DISCONNECT THE INPUT LINE CORD AND ALWAYS WAIT 5 MINUTES BEFORE OPENING THE SLIDING DOOR TO ALLOW INTERNAL STORED VOLTAGES TO DECAY. SEE FIGURE 3-1.

INTERNAL DIP SWITCH SELECTOR

Switch #	1	2	3	4
100	*	*	ON	*
115	*	*	OFF	*
220	OFF	ON	*	*
230	OFF	OFF	*	*
240	ON	OFF	*	*

CLOSE SLIDING DOOR AFTER CHANGING SWITCH POSITIONS BEFORE RECONNECTING LINE CORD.

* DON'T CARE
**SWITCH INPUT OFF BEFORE CHANGING VOLTAGE RANGE

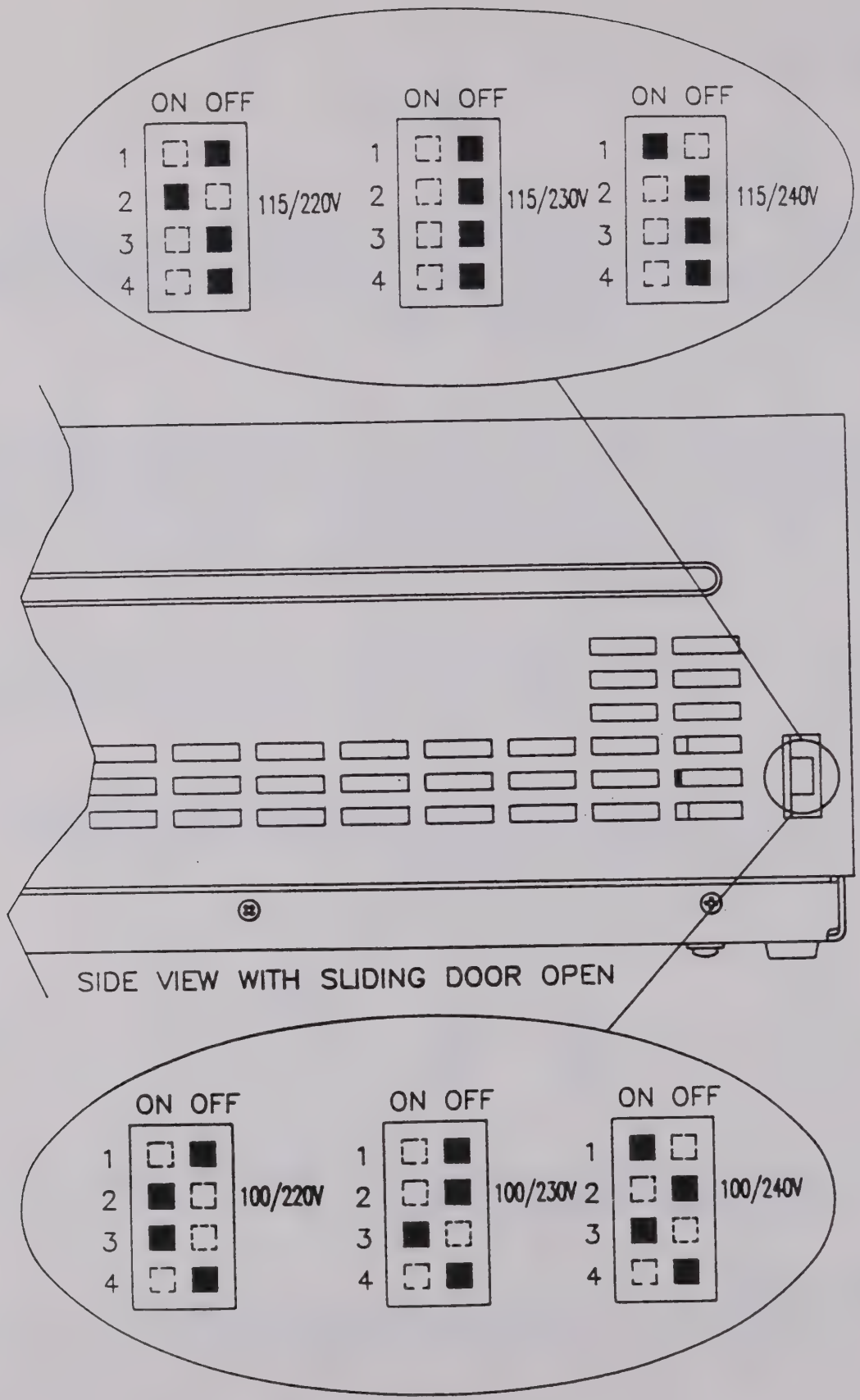

FIGURE 3–1
DIP SWITCH LOCATION, (BEHIND DOOR)
ON OSCILLATOR PC ASSY

3.4 FRONT PANEL CONTROLS

The OUTPUT ON/OFF switch, electronically inhibits the operation of the output. It does not mechanically disconnect or isolate the output wiring.

The VOLTAGE control push button switches select nominal or ±10% of the programmed output voltage. The FREQUENCY push button switches will select either nominal or ±3 Hz of the 50 or 60 Hz frequency selected.

3.5 FRONT PANEL INDICATORS

The OUTPUT ON/OFF indicator light when lit shows that the output is on. The red overload light will be lit if the output load is 5% or more than full rated load.

The appropriate VOLTAGE indicator light will be lit once the unit is energized, even if the output ON/OFF switch is off. The LEDs next to the VOLTAGE select switches will be lit to show whether +10%, nominal, or -10% has been selected.

In the FREQUENCY control panel section either the 50 Hz or 60 Hz indicator will be lit. The +3 Hz, nominal, or -3 Hz LED will be on depending on the selection mode.

Output voltage light above outlets will be lit whenever high voltage is present.

3.6 REAR PANEL CONNECTIONS

An IEC 320-C20 type input connector is provided for input power. The input cord must be sized correctly to carry the input current at the input operating voltage. This is 20A at low input voltages, (100-126V), or 10A at high input voltages (200V to 265V).

3.7 FRONT PANEL CONNECTIONS

The output is available from a duplex USA style connector and a single European style connector. If the low range is selected, the US style connector is live and the European connector is not active. If the high range is selected then only the European connector can deliver power. When the power is present on the output sockets, the neon lamp above them will be lit.

SECTION 4

CALIBRATION

4.1 GENERAL

Calibration is not normally required as all modules are factory preset and sealed in order for them to be field interchangeable. A digital multimeter may be connected to the output sockets and the different output voltages selected to verify that the output is within the accuracy specified in the "SPECIFICATIONS".

A frequency or Universal Counter with an accuracy of greater than 0.1% may be used to verify the output frequency accuracy. The frequency counter should be connected by means of a 10:1 probe to prevent damage to the input circuits.

SECTION 5

THEORY OF OPERATION

5.1 GENERAL

The unit is designed to be operated from any supply from 100 to 240 volts AC, 50 or 60 Hz and deliver any one of 5 preset voltages from 100 to 240 volts at either 50 or 60 Hz.

5.2 OVERALL DESCRIPTION (See Figure 5-1)

The AC input is fed to a power factor-correcting, boost-type converter. This converter steps the voltage up to 385 VDC while drawing only sinusoidal unity power factor current from the input power line.

The DC to DC converter provides isolation and changes the voltage to 250 VDC or 400 VDC depending on whether the low output range or high output range is selected.

The A.C. converter develops an AC sine wave voltage at the output that is either 50 or 60 Hz depending what is selected.

The oscillator board provides the reference signal to the AC converter and has the front panel switches mounted on it to control the output frequency and voltage.

5.3 POWER FACTOR CORRECTION MODULE (See Figure 5-2.) (PFC)

The P.F.C. consists of an input EMI filter, input bridge and a boost converter. The boost converter is PWM controlled by a single chip that adjusts the pulse width during the cycle so that only a pure sine wave CURRENT is drawn from the supply. An auxiliary winding on the boost inductor provides "bootstrap" power to the logic circuits and is self sustaining.

5.4 DC-DC CONVERTER MODULE

The 385 VDC from the boost converter is fed to the DC-DC module. It first supplies 385 volts DC to the Auxiliary Power Supply (Aux. P.S.). When the Aux starts up and runs, it supplies 6 isolated logic level supplies to the A.C. module. It also supplies 15 volts to the D.C. converter on the same D.C. module. The DC-DC converter then can start running. The D.C. converter supplies either 250 volts DC or 400V DC to the DC-AC module.

The DC-DC converter is a full bridge converter and the auxiliary converter is a two FET forward converter.

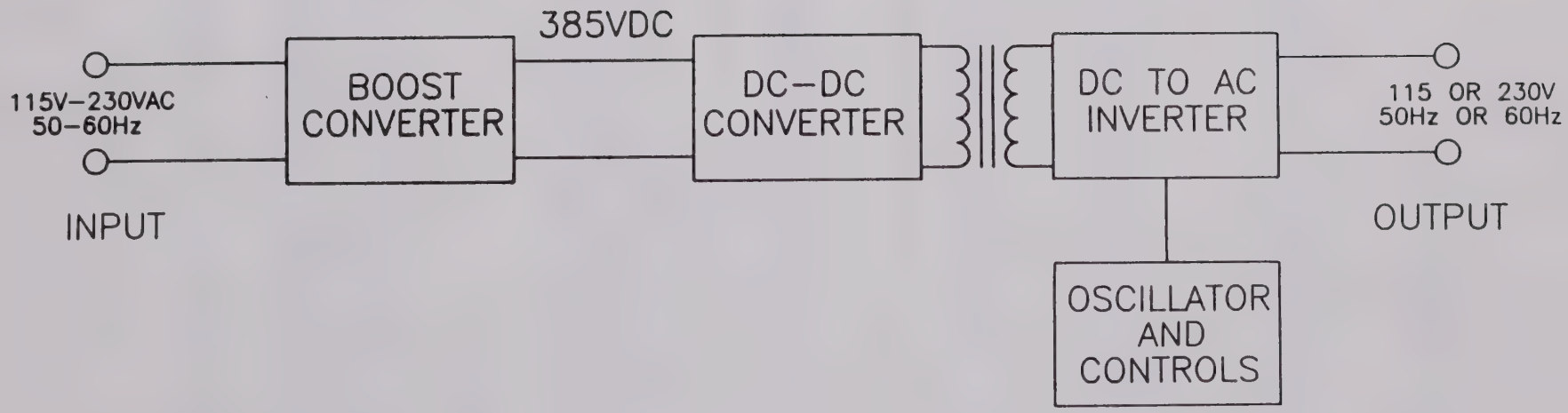

Figure 5–1
BLOCK DIAGRAM
PORTABLE FREQUENCY CONVERTER

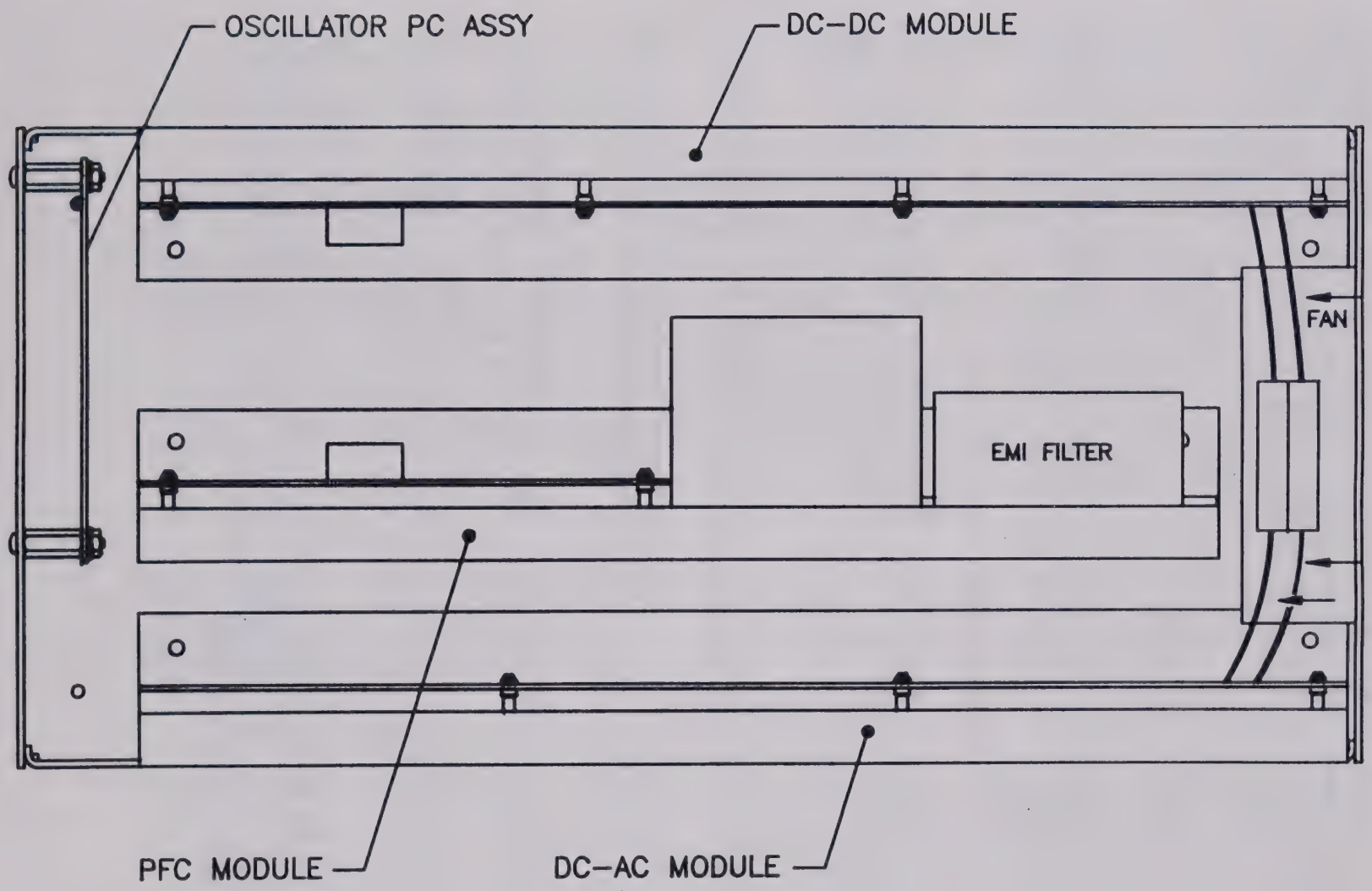

Figure 5–2

1251WP TOP VIEW
(WITH COVER REMOVED)

All the 8 LEDs on the DC-DC board should be lit under normal operation. The LED DS200 is lit when the DC output is up and within regulation. The amber LEDs DS5, DS4 and DS3 indicate that 15V power to the optocouplers on the AC Converter are within regulation. The red and green LEDs DS7 and DS6 indicate logic power OK to the AC converter. The LED DS8 shows logic power to the DC converter is within specifications at 15 volts. The LED DS2 shows 24 volt fan power is available.

5.5 OSCILLATOR BOARD

The oscillator board receives power from the DC-AC module. This board uses programmable logic devices, PLDs, to control the frequency and amplitude of the reference signal used to control the AC converter output.

5.6 DC-AC POWER MODULE

The DC to AC Power Module takes a 250V DC input and generates the 100V or 115 volt directly coupled low range A.C. outputs. When supplied with 400 volts DC the AC module develops a 220V, 230V or 240V directly coupled AC output. The output converter is a P.W.M full bridge with L.C. filtering on the output. The switching frequency is 31.25 kHz.

The module has pulse by pulse peak current limit and sinusoidal average current limiting to protect the power transistors and the load.

A slight overload of 20% will cause the output voltage to sinusoidally decrease in a constant current mode (e.g. output voltage would reduce to 100V at 13 Amps on the 115V output range) after approximately 1 second.

A heavy overload slowly applied will cause the output voltage to sinusoidally reduce down to 15 to 20 volts and the current to be constant at 13 Amps approximately.

Reducing the load to zero ohms (short circuit) will cause the peak current limit to come into effect limiting the current peaks to 35 Amps. This will continue for 3 to 5 seconds and then the unit will latch off until AC input power is recycled.

Applying a sudden overload (e.g. 3 ohms to a 115V output) will cause the converters supplying the AC converter to go into current limit and reduce the DC bus available to the AC converter. The AC converter will be forced to peak clip, flat topping the output waveform. After one second, the output will reduce sinusoidally into the constant current mode of 1 and 2 above.

SECTION 6

MAINTENANCE AND TROUBLESHOOTING

6.1 GENERAL

This section describes the suggested maintenance and troubleshooting procedures. Table 6.1 lists the symptoms and paragraph numbers for the troubleshooting section. If the frequency converter does not appear to function normally use this section to isolate the problem. The troubleshooting is broken down into two sections; first level and advanced. Only qualified electronic technicians should attempt the advanced troubleshooting section.

If the problem cannot be found using these steps, consult the factory.

TABLE 6-1

PARAGRAPH		PAGE NO.
6.2	POOR OUTPUT VOLTAGE REGULATION	14
6.3	OVERLOAD LIGHT ON	14
6.4	DISTORTED OUTPUT	15
6.5	UNIT SHUTS DOWN AFTER 3-5 SECONDS	15
6.6	NO OUTPUT	15

6.2 POOR OUTPUT VOLTAGE REGULATION

a)	Unit is overloaded	Remove overload
b)	Unit is switched to wrong voltage range, causing overload	Turn off unit and select correct output voltage range.
c)	Input line has fallen below 85 volts	Check supply voltage.

6.3 OVERLOAD LIGHT IS ON

a)	Unit is overloaded	Remove overload
b)	Unit is switched to too high voltage range	Turn off unit and select correct output voltage range

6.4 DISTORTED OUTPUT

The AC power system output may have a distorted sine wave from the following causes:

a)	Power source is grossly overloaded	Reduce overload
b)	The crest factor of the load exceeds 3:1	Reduce load current peaks

6.5 UNIT SHUTS DOWN AFTER 3-5 SECONDS

If the unit appears to run but shuts down after 3-5 seconds, it is probably due to one of the following causes:

a)	Output shorted	Remove output short
b)	Output grossly overloaded	Remove overload
c)	Operating load with too high inrush or start up currents that last more than 3 seconds	Consult factory for application advice

6.6 NO OUTPUT

a)	No output and no lights on front panel	Is the rear panel power switch in the "ON" position? Is unit plugged in to a "live" supply? Are power cords in good condition? Is fuse blown? Check fuse and replace with same type and rating.
b)	No output but LEDs on front panel are lit.	Is "output on" switch depressed? Is power cord plugged into the correct socket output? Only the USA socket is energized when low range is selected, etc. Is the appliance being operated switched on?

6.7 ADVANCED TROUBLESHOOTING. ONLY PERSONNEL WITH ELECTRICAL/ELECTRONIC KNOWLEDGE SHOULD PROCEED BEYOND THIS POINT.

CAUTION

Voltages up to 480 VAC are available in certain sections of this power source. This equipment generates potentially lethal voltages.

DEATH
on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied.

Switch off unit. Remove line cord and wait 5 minutes for all internal capacitors to discharge.

Remove cover screws and remove cover.

Step 1: Ensure all connectors are properly mated and there are no broken wires.

Step 2: Plug unit in and observe the LEDs.

a) No output, no front panel LEDs — Is LED on P.F.C. unit lit? OK if flickering with no load on output. If not lit, check input fuse and wiring on P.F.C. module. P.F.C. module is the one in the center. If lamp is not lit and power is available at the EMI filter, replace P.F.C. module.
If LED is lit, proceed to DC-DC converter. The DC-DC converter is on the left hand side when looking at the front. Are LEDs lit on the DC to DC board?

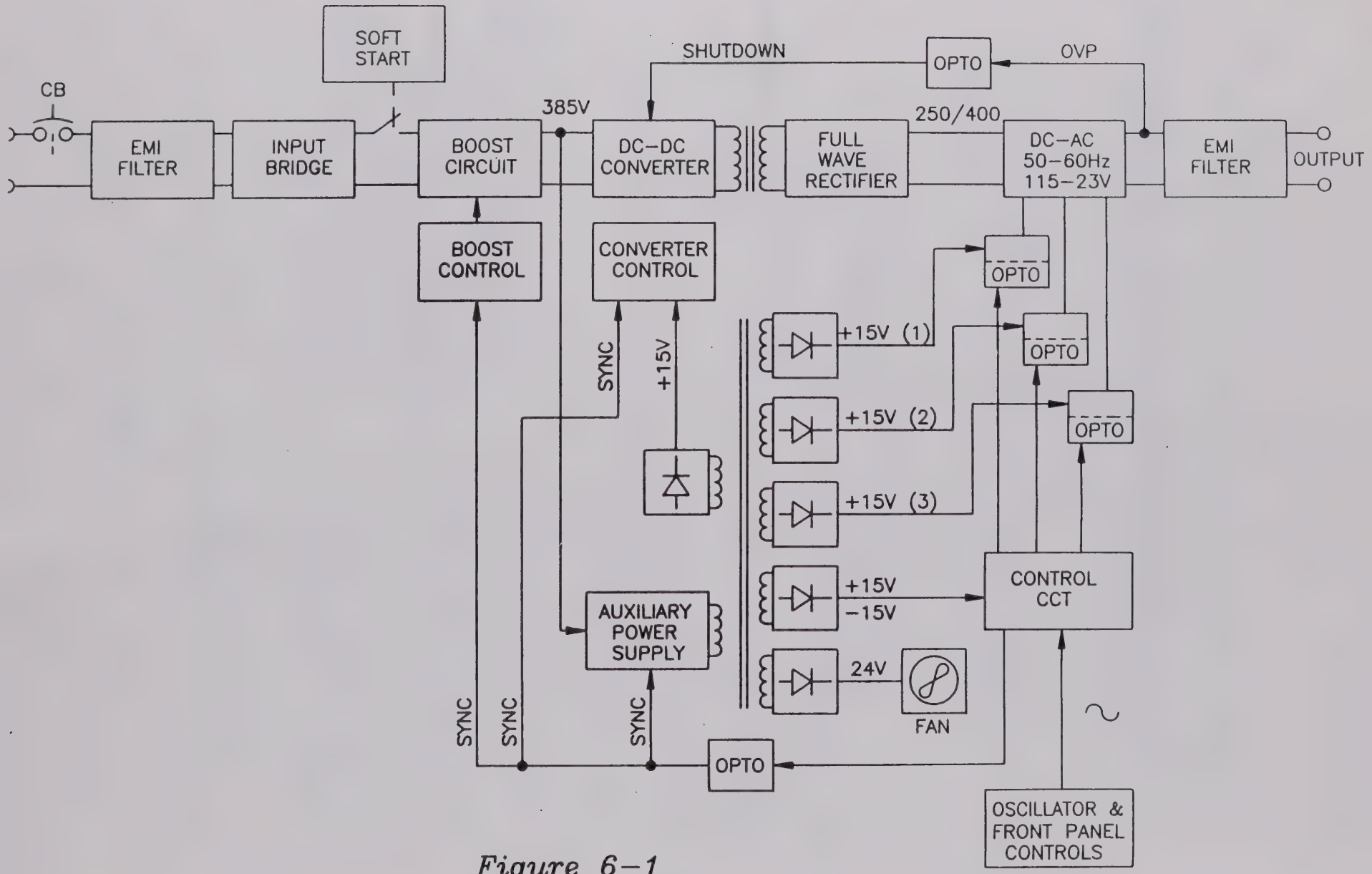

Figure 6–1
BLOCK DIAGRAM
PORTABLE FREQUENCY CONVERTER

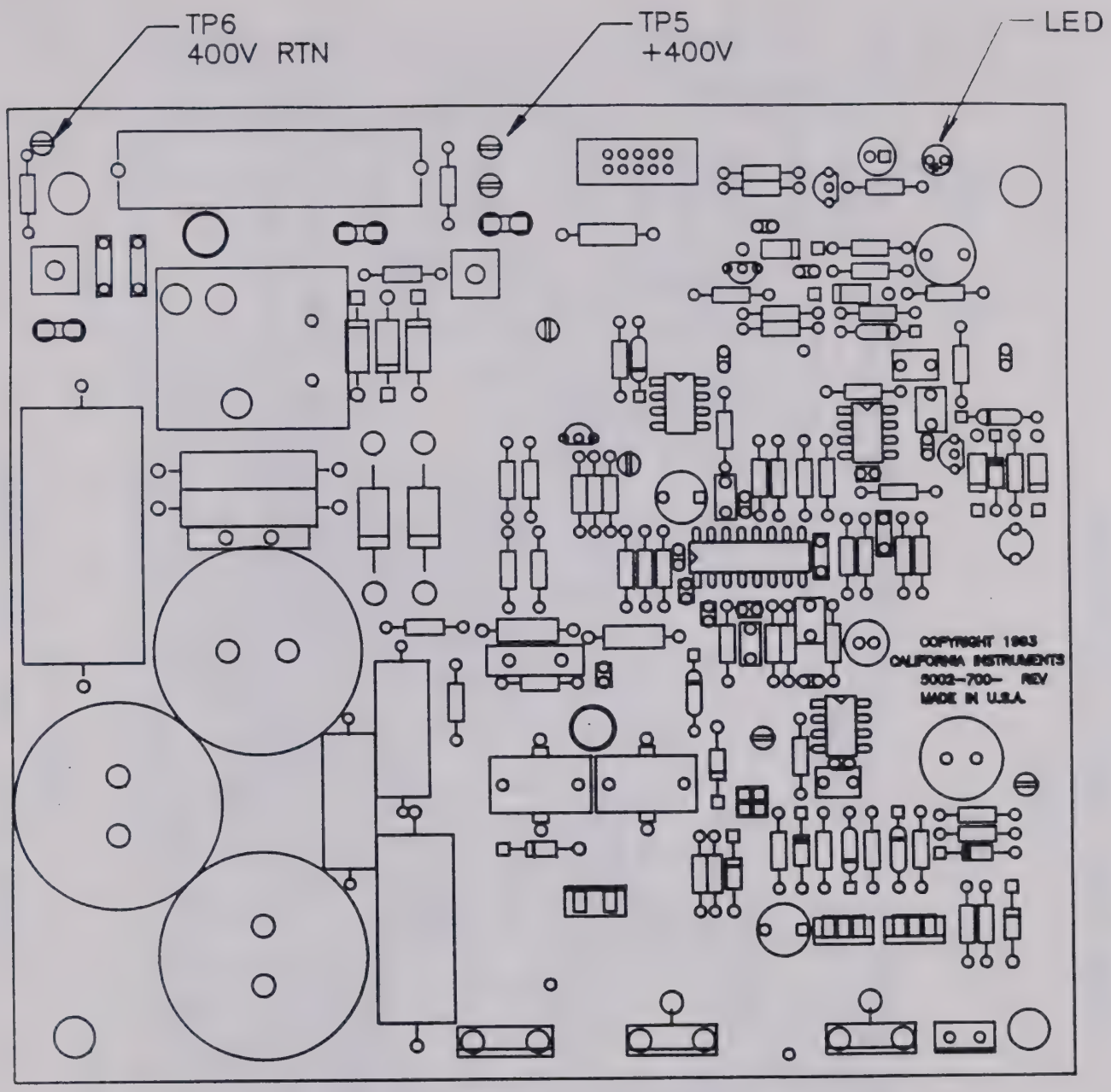

Figure 6-2

TEST POINT LOCATION
PFC MODULE

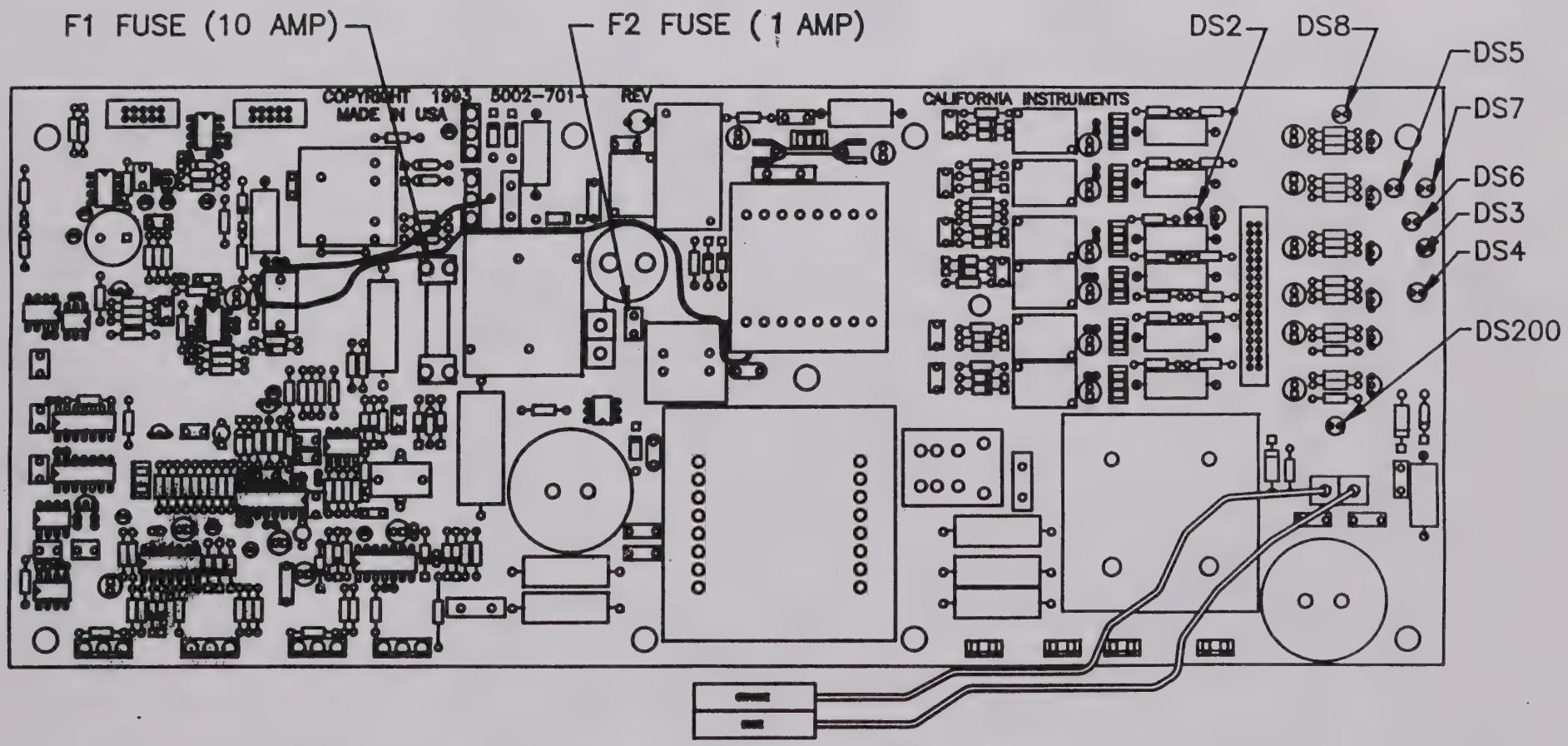

Figure 6-3

FUSE AND LED LOCATIONS
DC-DC MODULE

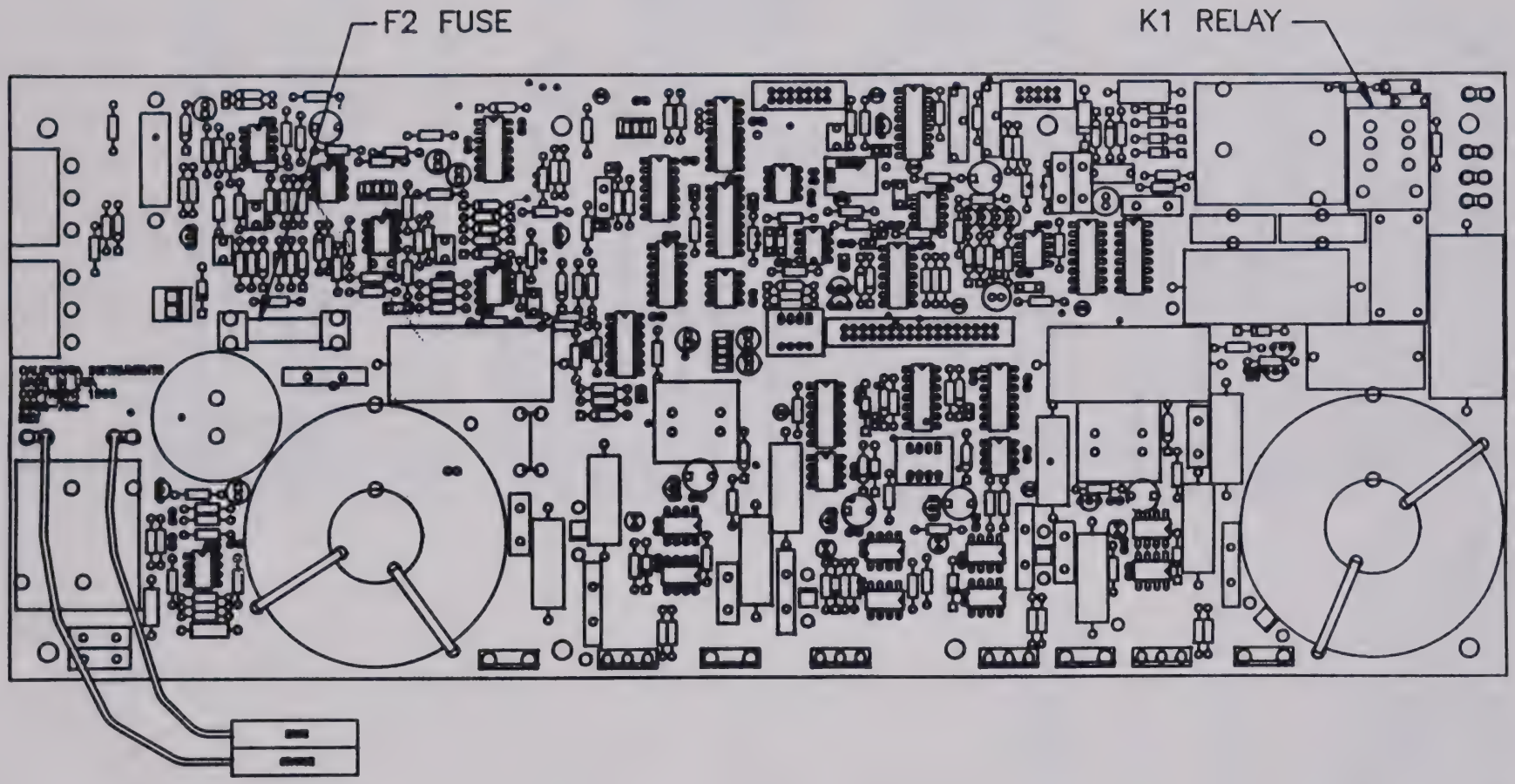

Figure 6-4

FUSE AND RELAY LOCATION
DC-AC MODULE

	YES	NO
	If LEDs on the DC-DC board are lit and front panel LEDs are not lit, the problem is probably in the large ribbon cable that runs between the DC-DC and the AC converter.	Check fuses on the DC-DC converter board. There is a 3 AMP (F2) fuse and a 10 Amp (F1) fuse both located in the center of the PC board. You will have to remove the two screws at the bottom of the unit to remove the module in order to replace the fuses. **TURN OFF THE UNIT AND WAIT 5 MINUTES BEFORE REMOVING MODULE.** If fuses are blown and there are signs of burn marks on the components, do not replace fuses and power up. Replace DC-DC module.
b)	No output. LEDs on front are lit.	Plug unit in and switch on. Are all the LEDs lit on the DC-DC board? 3 amber LEDs (DS3, DS4, DS5) - if one or more of these LEDs is not lit the trouble is on the DC-AC board. Unplug the cable to the DC-AC module (after safely removing power). If all the LEDs are lit after power up, replace the DC-AC module as it has a shorted gate drive and probably blown power transistors. Red and green LEDs, DS6 and DS7, on the back of the board provide power to DC-AC and the oscillator board. If either of these are not lit, switch off power, remove large ribbon cable from DC-DC converter and power up again. If LEDs are lit, the problem is on the DC-AC or the oscillator board. If the LEDs remain off, replace the DC-DC board. If LED, DS8, is not lit, no power will be available to run the DC converter drive logic. Replace DC-DC module. LED, DS2 (red), indicates 24V fan power available. LED, DS200, will be lit if the DC converter is running. If DS200 is not lit check fuse F1 on the DC-DC board as in paragraph 6.7(a) above. If all LEDs are lit and neon output voltage indicator is ON but no output, then suspect relay on DC-AC board.

If all 8 LEDs are lit on the DC-DC converter then the problem is on the DC-AC module. Switch off, then check wiring from the DC-AC board output to the output sockets on the front panel. If this is OK check the fuse, F2, on the DC-AC module. Switch off. Remove two screws from the underside of the enclosure to gain access to the module and F2. If the fuse is blown and a check shows signs of damage or burning on the board, **DO NOT REPLACE FUSE.** Replace DC-AC module. If there are no signs of burning or damage on the DC-AC board or components, then it could be assumed that it is a random fuse failure and it would be OK to replace the fuse and try again.

WARNING

In most cases when a fuse blows it is caused by a failed power semiconductor and repeatedly replacing a fuse will only cause severe damage to that or other assemblies.

SECTION 7

REPLACEABLE PARTS

7.1 GENERAL

This section contains ordering information and a list of replaceable parts. The list includes the parts description and California Instruments part numbers.

7.2 ORDERING INFORMATION

In order to ensure prompt, accurate service, please provide the following information, when applicable for each replacement part ordered.

a. Model number and serial number of the instrument.

b. California Instruments part number for the subassembly where the component is located. (PARENT ITEM NO.)

c. Component reference designator. (SEQ NO.)

d. Component description.

e. Component manufacturers' FSCM number. (VENDOR)

f. California Instruments' part number (COMPONENT ITEM NO.)

All replaceable part orders should be addressed to:

California Instruments
Attention: Customer Service
9025 Balboa Avenue
San Diego, California 92123-1509

TOP ASSY, 1251WP
5002-406-1

	SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION		VENDOR	QTY
	A1	5002-401-1	HEATSINK ASSY, PFC		16067	1
	A2	5002-402-1	HEATSINK ASSY, DC-DC		16067	1
	A3	5002-403-1	HEATSINK ASSY, DC-AC		16067	1
	A4	5002-703-1	PC ASSY, OSCILLATOR		16067	1
	B1	241184	FAN, 4"M24CDX		0D1M6	1
**	F1	270176	FUSE, 20A, 250V		75915	1
	J1	410640	CONN,RCPT,3 PIN,PWR INPUT	61935		
	J2	410621	CONN,AC,RCPT,3W,DUP.125V		72041	1
	J3	410589	CONN,RCPT,3 SOC,EUROPEAN		5F520	1
	S1	240547	SWITCH,ROCKER,SPDT		82389	1
	XF1	250587	FUSE HOLDER, CHASSIS		61935	1
		250596	FUSE CARRIER,1-1/4"X1/4		61935	1
			FUSE CARRIER,5X20mm		61935	1
	CR1	310324	BRIDGE RECT,FW,35A,800V		04713	1
	F1	270151	FUSE,10A, (DC-DC) BOARD		71400	1
	F2	270183	FUSE,3A, -PCC3(DC-DC)		71400	1
	F2	270167	FUSE,15A, (DC-AC BOARD)		71400	1
	F1	270182	FUSE,10A,250V,(PFC BOARD)		61935	1

7.3 USER REPLACEABLE REAR PANEL INPUT FUSE

INPUT FUSE	BUSSMAN PART NO.
* FUSE 20A 250V	ABC-20

Appendix A

Number	Vendor Name	City	State
0000A	Electricord	Westfield	PA
0000C	Jackson Bros.	Waddon,Surrey	GB
0000S(28564)	OPCDA (Refac Elect. Corp.)	Winsted	CT
0000W	Milton Roee Co.	Southampton	PA
0000Z(52745)	Tilmco	Los Angeles	CA
0000AC	Itac	Santa Clara	CA
0000AD(55112)	Plessey (Westlake Cap. Inc.)	Westlake Village	CA
0000AG	Lafrance	Philadelphia	PA
0000AN(54363)	Jan Crystal	Ft. Myers	CA
0000AL(53495)	Data Components, Inc.	Gardena	CA
0000AM	Erwin & Weimer	Santa Monica	CA
0000AN	Ritz Instrument Transformer	Redondo Beach	CA
0000AS	Switches Incorporated	Mt. View	CA
0000AT(62643)	United Chemi-Con	Rosemont	IL
0000AU	JMJ Technical Prod. Inc.	Kendall Park	NJ
0000AV(61837)	Semi Processes, Inc.	San Jose	CA
0000AW	Wirose	Chatsworth	CA
0000AX(63878)	Aptronics	Mentor	OH
0000AY	Silicon Power Cube Corp.	Long Beach	CA
0000AZ(61271)	Fujitsu	Santa Clara	CA
0000BA(61964)	Omron Electronics, Inc.	Schaumburg	IL
0000B	Wellmart Metals, Inc.	Glendora	CA
0000BC	Toshiba America, Inc.	Tustin	CA
0000BD(55982)	Electronic Essentials	Woodside	NY
0000BE(57856)	Eal-Am	Eldon	MO
0000BF(55285)	Berquist	Minneapolis	MN
0000BG	Panasonic	Secaucus	NY
0000BH	Century Components	Canyon Country	CA
0000BI(56186)	Micro Power Systems	Santa Clara	CA
0000BJ(06776)	Robinson Nugent	New Albany	IN
0000BL(13150)	Beau Products (Varnitron)	Laconia	NH
0000BM(91725)	Corebinder (Cerrard AJ & Co.)	Des Plaines	IL
0000D	Mitsubishi Electronics Amer.	Sunnyvale	CA
0000P	Silicon Power Cube	Long Beach	CA
0000R	Secme	Bagnolet	France
0000S	Panel Components Corp.	Santa Rosa	CA
00544	Metal-Cal Div., Avery Prod.	Inglewood	CA
00779	AMP Inc.	Harrisburg	PA
00853	Sangamo Electronic Co.	Pickens	SC
00866	Goe Eng. Co., Inc.	City of Industry	CA
01002	G.E. Co., Ind. & Pwr. Cap. Dept.	John St. Hudson Falls	NY
01121	Allen-Bradley Co.	Milwaukee	WI
01139	G.E. Co., Silicone Prod.	Waterford	NY
01295	Texas Instruments	Dallas	TX
01961	Pulse Engineering, Inc.	San Diego	CA
02111	Spectrol Electronics	City of Industry	CA
02113	Coilcraft, Inc.	Cary	IL
02335	Fairchild Controls Corp.	Hicksville,LI	NY
02375	American Insulating Mach. Co.	Philadelphia	PA
02538	Texas Electronics Co.	Dallas	TX
02660	Amphenol Corporation	Broadview	IL
02768	Illinois Tool Works, Inc.	Des Plains	IL
02799	Gae Code #72136		
03507	General Electric Company	Syracuse	NY
03508	General Electric Company	Syracuse	NY
03797	Eldema Corporation	Compton	CA
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls	NJ
03911	Claires Corporation	New York	NY
04009	Arrow-Hart and Hegeman Elec.	Hartford	CT
04099	Capco, Inc.	Grand Junction	CO
04713	Motorola Semiconductor Prod.	Phoenix	AZ
04729	Universal Components Corp.	Green Brook	NJ
04963	3-M	St. Paul	MN
05245	Corcom Inc.	Chicago	IL
05276	Pomona Electronics., Inc.	Pomona	CA
05397	Kemet, Union Carbide Corp.	Cleveland	OH
05791	Lyn-Tron, Inc.	Burbank	CA
05820	Wakefield Engineering, Inc.	Wakefield	MA
05972	Loctite Corp.	Newington	CT
06383	Panduit Corp.	Tinley Park	IL
06514	Stanton, Wyco Metal Prod.	N. Hollywood	CA
06540	Amaton Elect. Hardware	New Rochelle	NY
06665	Precision Monolithics Inc.	Santa Clara	CA
06776	Robinson Nugent, Inc.	New Albany	IN
06915	Richco Plastics, Co.	Chicago	IL
07088	Kelvin Electric Company	Van Nuys	CA
07263	Fairchild Camera & Instr.	Mt. View	CA
07387	Birtcher Corporation	Los Angeles	CA
07556	Omitract Calabro Plastics	Upper Darby	PA
07633	Epoxy Prod. Co., Allied Prod. Corp.	New Haven	CT
07707	USM Corp. (USM Fastener Div)	Shelton	CT
07716	IMC Incorporated	Burrington	IA
07910	Gae Code #15818		
08028	Loctite (Auto & Consumer Grp)	Mtn View	CA
08057	Spang Ind. (Magnetics Div)	Sandy Lake	PA
08065	Accurate Rubber and Plastics	San Diego	CA
08261	Spectra Strip (Amphenol)	Garden Grove	
08289	Allan Delbert Co.	Pomona	CA
08353	Bristol Co. of Canada	Toronto, Ont	Canada
08730	Oakby & Barton (Vemaline Prod. Div.)	Warwick	RI
08779	Signal Transformer	Brooklyn	NY
09214	GE (Semiconductor Prod. Div)	Auburn	NY
09353	C & K Components	Newton	MA
09922	Burndy Corp.	Norwalk	CT
10389	Chicago Switch	Chicago	IL
11815	Cherry/Textron (Fastener Div)	Santa Ana	CA
12406	Elpac Electronics	Santa Ana	CA
12697	Clarostat Mfg.	Dover	NH
13103	Thermalloy Company	Dallas	TX
13150	Varnitron Corp (Beau Prod.)	Laconia	NH
13606	Sperry Corp. Elec. Systems	Great Neck	NY
13919	Burr-Brown	Tucson	AZ
14099	Sealtech Corporation	Newbury Park	CA
14604	Elmwood Sensors Inc.	Cranston	RI
14655	Cornell-Dubilier Elect. Corp.	Newark	NJ
14726	Bellingsworth Co.	Phoenixville	PA
14752	Electro Cube, Inc.	San Gabriel	CA
14900	Electronic Instrument and Specialty Corp.	Stoneham	MA
15238	ITT Semiconductors	Lawrence	MA
15454	Ametek EMI (Boden Div)	Anaheim	CA
15636	Elec-trol	Northridge	CA
15801	Fenwell Electronics	Framingham	MA
15818	Amelco Teledyne, Inc.	Mt. View	CA
15912	Ansley	Los Angeles	CA
16067	California Instruments Co.	San Diego	CA
16758	Delco Radio Div., Gen. Mtrs.	Kokomo	IN
16956	Dennison	Framingham	MS
17956	Silicomi, Inc.	Santa Clara	CA
18076	Dupco	City of Industry	CA
18178	Vactec, Inc.	Maryland Heights	MO
18310	Concord Electronics Corp.	New York	NY
18324	Signetics	Sunnyvale	CA
18612	Vishay Instruments, Inc.	Malvern	PA
18677	Scambe Mfg. Co. (Iere Corp.)	Monterey Park	CA
18722	MCA	Mountaintop	PA
18736	Voltronics Corp.	Hanover	NJ
19080	Robison Company	Hawthorne	CA
21604	Buckeye Stamping Company	Columbus	OH
21845	Solitron Devices (Semi-conductor Group)	Riviera Beach	FL
22599	Elastic Stop Nut Corp.	Van Nuys	CA
23050	Product Components Corp.	Hastings-on-Hudson	NY
23936	Pasotor, Inc.	San Francisco	CA
24011	ECC	Burlington	MA
24355	Analog Devices, Inc.	Norwood	MA
24444	General Semiconductor Inc.	Tempe	AZ
24796	Paralco, Inc.	Paramount	CA
24931	Specialty Connector Co., Inc.	Greenwood	IN
24972	AEG-Telefunaen Corp.	Summerville	NJ
25403	Amperex Electronic Corp.	Slatersville	RI
25497	Meter Master	Los Angeles	CA
26405	Marathon Electric Mfg. Corp.	Bowling Green	OH
26806	American Settler, Inc.	Costa Mesa	CA
27014	National Semi-Conductor Corp.	Santa Clara	CA
27191	Cutler-Hammer, Inc.	Milwaukee	WI
27264	Molex	Downers Grove	IL
27335	B & B Motor & Control Corp.	New York	NY
27556	IRB Electronic Products	Santa Fe Springs	CA
27680	Vare, Inc.	St. Garland	TX
27735	F-Dyne Electronics	Bridgeport	CT
27832	Hughes Aircraft	Newport Beach	CA
28480	Hewlett-Packard Co.	Palo Alto	CA
28520	Heyman Mfg. Company (Heycot	Kenilworth	NJ
28606	Echlin Ltd.	Rexdale Ont.	Canada
29372	Rexnord Inc. Tridair Ind.	Torrance	CA
29593	Sussco Eng. Inc.	El Segundo	CA
30039	International Components Crp.	Asbury Park	NJ
30161	Axvid Engineering, Inc.	Laconia	NH
30897	Dorsan Company	Sylmar	CA
30983	Electra/Midland (Repco/ Electra)	San Diego	CA
31827	Budvig Mfg. Co.	Ramona	CA
31951	Triridge, Inc.	Pittsburg	PA
32293	Intersil	Cupertino	CA
32559	Bivar, Inc.	Santa Ana	CA
32997	Bourns Inc. (Trimpot Div)	Riverside	CA
33005	Jewell Electrical Inst. Inc.	Manchester	NH
33135	Logic Dynamics, Inc.	Gardena	CA
33716	Kingsabbey Murray Co.	Los Angeles	CA
33855	Ducommun, Inc.	Los Angeles	CA
33901	Colber Corp.	Irvington	NJ
34218	Mills Resistor Co.	Los Alamitos	CA
34333	Silicon General	Westminster	CA
34649	Intel Corporation	Santa Clara	CA
35007	Aerovox Canada Ltd.	Amherst NE	Canada
37964	Linear Technology, Inc.	Burlington, Ont	CAN
44655	Ohmite Manufacturing Co.	Skokie	IL
45722	Parker-Kalon	Clifton	NJ
46384	Penn. Eng. and Mfg. Corp.	Doylestown	PA
50157	Midwest Components, Inc.	Muskegon	MI
50522	Monsanto, Electronic Special Products	Cupertino	CA
50550	Electronic Concepts, Inc.	Eatontown	NJ
50811	Newser Corp.	Santee	CA
51167	Arlee Electronics, Inc.	Frenchtown	NJ
51506	Accurate Screw Machine Co.	Hutley	NJ
51705	ICO/Rally	Palo Alto	CA
52072	Circuit Assembly Corp.	Costa Mesa	CA
52745	Tilmco	Los Angeles	CA
53076	Elntex, Inc.	Buffalo	NY
53495	Data Components, Inc.	Gardena	CA
54361	Edwards Sheet Metal Works	Fredericktown	OH
54407	Power-One, Inc.	Camarillo	CA
55322	Samtec, Inc.	New Albany	NY
55566	BAF Electronic Hardware, Inc.	Seymour	CT
56289	Sprague Electric Company	North Adams	MA
56637	RCD Components, Inc.	Manchester	NH
57640	United Chem-Con Corp.	Philadelphia	PA
57856	Eal-Am, Inc.	Eldon	MO
58474	Superior Electric Company	Bristol	CT
59730	Thomas and Betts Company	Elizabeth	NJ
59993	International Rectifier Semiconductor Div.	El Segundo	CA
60395	Elcar, Inc.	Milditas	CA
61394	Seeq Technology, Inc.	San Jose	CA
61441	Seromis	Palo Alto	CA
61529	Aromat Corp.	Mountainside	NJ
61735	Pulse Engineering, Inc.	College Park	MD
62483	Denkitron Corp. of America	Torrance	CA
62643	United Chemicon, Inc.	Rosemont	IL
62786	Hitachi America Ltd.	San Jose	CA
63743	Ward Leonard Electric Co.	Mt. Vernon	NY
63791	Star Micronics, Inc.	New York	NY
70318	Allmetal Screw Prod. Co.	Garden City	NY
70903	Belden Manufacturing Co.	Chicago	IL
71218	Bud Industries, Inc.	Willoughby	OH
71279	Cambridge Thermionic Corp.	Cambridge	MA
71400	Bussmann Mfg. Div. McGraw-Edison, Co.	St. Louis	MO
71450	CTS Corporation	Elkhart	IN
71468	ITT Cannon Electric, Inc.	Los Angeles	CA
71590	Centralab Div. Globe-Union	Milwaukee	WI
71707	Coto-Coil	Providence	RI
71744	Chicago Miniature Lampworks	Chicago	IL
71785	Cinch Manufacturing Company	Chicago	IL
71984	Dow Corning Corp.	Midland	MI
72136	Elmenco (Electro Motive)	Williamantic	CT
72619	Dialight Corporation	Brooklyn	NY
72699	General Instruments	Newark	NJ
72982	Erie Technological Prod. Inc.	Erie	PA
73138	Beckman Instruments, Inc.	Fullerton	CA
73612	Consolidated Electronic Wire and Cable Corp.	Chicago	IL
73734	Federal Screw Products, Inc.	Chicago	IL
74193	Heinemann Electric Company	Trenton	NJ
74545	Harvey Hubbell, Inc.	Bridgeport	CT
74868	Illinois Capacitor Co.	Chicago	IL
74970	E.F. Johnson Company	Waseca	MN
75042	TRW Electronic Components	Philadelphia	PA
75382	Kulka Electric Corporation	Mt. Vernon	NY
75582	Lewiton Mfg. Co.	Little Rock	NY
75915	Littelfuse, Inc.	Des Plaines	IL
76385	Miner Rubber Co., Inc.	Bloomfield	NJ
77062	Pabst Eng. Equipment Co.	Elizabeth	NJ
77132	United-Carr Inc., Pacwin Div	Waterbury	CT
77342	Potter and Brumfield Div, AMF	E. Princeton	IN
78189	Shakeproof Div. IL Tool Works	Chicago	IL
78553	Tinnerman Products, Inc.	Cleveland	OH
79136	Johns-Manville Products Corp	Chicago	IL
79136	Waldes Kohinoor Inc.	Long Island City	NY
79963	Zierick Mfg. Corp.	New Rochelle	NY
80031	Repco/Electro	Morristown	NJ
80223	United Transformer Co.	New York	NY
80294	Bomers, Inc.	Riverside	CA
80495	High Voltage Engineering Corp (Anderson Pwr Prod. Div)	Brigston	MA
81095	Triad Transformer Corp.	Venice	CA
81312	Winchester Electronics	Oatville	CT
81348	(Fed. Specs) Promulgated by General Services Administration Washington DC		
81349	Military Specification or Commercial Generic Number		
81541	Airpax Corp.	Cambridge	MD
81603	Race Precision Co.	Chicago	IL
81851	Beckley-Harris Mfg Co.	Lionville	PA
82104	Standard Grigsby	Aurora	IL
82389	Switchcraft, Inc.	Chicago	IL
82877	Bertron Mfg. Co., Inc.	Woodstock	NY
82893	Vector Electronics, Inc.	Sylmar	CA
83330	Herman H. Smith, Inc.	Brooklyn	NY
83486	Elco Tool & Screw Corp.	Rockford	IL
83540	Brady W.H. Co.	Milwaukee	WI
84684	MCA	Harrison	NJ
86928	Seastrom Mfg. Co., Inc.	Glendale	CA
87034	Marco-Oak Industries	Anaheim	CA
88245	Oaeco Div., Litton Ind.	Van Nuys	CA
90201	Mallory Capacitor Co.	Indianapolis	IN
91506	Aames, Inc.	Attleboro	MA
91637	Dale Electronics, Inc.	Columbus	NE
91662	Elco Corporation	Willow Grove	PA
91802	Industrial Devices, Inc.	Edgewater	NJ
91833	Keystone Electronics Corp.	New York	NY
91947	National Tel-Tronics	Meadville	PA
92194	Alpha Wire Corp.	Elizabeth	NJ
93303	Pentagon Products Co.	Washington	DC
94222	Southco, Inc.	Lester	PA
94698	Magnecraft Electric Co.	Chicago	IL
95146	Alco Electronic Prod., Inc.	Lawrence	MA
95303	MCA	Cincinnati	OH
95354	Methode Manufacturing Corp.	Rolling Meadows	IL
95546	Arnold Engineering Co.	Marengo	IL
95987	Wechsler Company, Inc.	Chicago	IL
96906	Military Std		
97525	Electronic Engineering Co.	Santa Ana	CA
98159	Rubber Tech, Inc.	Gardena	CA
98291	Sealetc Corp.	Mamaroneck	NY
98374	Ieco Mfg. Co. (West)	Burbank	CA
98978	IERC	Burbank	CA
99017	Protective Closures Co., Inc. (Caplugs Div)	Buffalo	NY
99217	Bell Industries, Inc.	Delevan	NY
99742	Permacell	New Brunswick	NJ
99743	IMC	Haywood	CA
99800	Delevan Electronics Corp.	Aurora	NY

ONE YEAR WARRANTY

CALIFORNIA INSTRUMENTS CORPORATION warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. Excepted from this warranty are tubes, fuses, and batteries which carry the warranty of their original manufacturer where applicable. CALIFORNIA INSTRUMENTS will service, replace, or adjust any defective part or parts, free of charge, when the instrument is returned freight prepaid, and when examination reveals that the fault has not occurred because of misuse, abnormal conditions of operation, user modification, or attempted user repair. Equipment repaired beyond the effective date of warranty or when abnormal usage has occurred will be charged at applicable rates. CALIFORNIA INSTRUMENTS will submit an estimate for such charges before commencing repair, if so requested.

PROCEDURE FOR SERVICE

If a fault develops, notify CALIFORNIA INSTRUMENTS or its local representative, giving full details of the difficulty, including the model number and serial number. On receipt of this information, service information or a Return Material Authorization (RMA) number will be given. Add RMA No. to shipping label. Pack instrument carefully to prevent transportation damage, affix label to shipping container, and ship freight prepaid to the factory. CALIFORNIA INSTRUMENTS shall not be responsible for repair of damage due to improper handling or packing. Instruments returned without RMA No., or freight collect will be refused. Instruments repaired under Warranty will be returned by prepaid surface freight. Instruments repaired outside the Warranty period will be returned freight collect, F.O.B. CALIFORNIA INSTRUMENTS, San Diego, CA. If requested, an estimate of repair charges will be made before work begins on repairs not covered by the Warranty.

DAMAGE IN TRANSIT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed immediately with the carrier. A full report of the damage should be obtained by the claim agent, and a copy of this report should be forwarded to us. CALIFORNIA INSTRUMENTS will prepare an estimate of repair cost and repair the instrument when authorized by the claim agent. Please include model number and serial number when referring to the instrument.

Rental Terms & Conditions

The rental rate for any period beyond the rental period will be billed on a per diem basis at the rate of 1/30 of the monthly rate. Rental rates are subject to change without notice.

All equipment is subject to prior rental or sale unless reserved. Orders are accepted subject to GE's Rental Terms and Conditions and price/rate provisions in effect at the time the order is accepted.

SHIPMENT

Shipment will be made at the Customer's expense and risk of loss, unless GE's Product Shipment Guarantee option has been paid for by Customer, in accordance with GE's standard shipping and handling charges.

Equipment, manuals, and all operating supplies are to be returned by the Customer freight prepaid to the GE Rental/Lease return location designated on the shipping notice received with the equipment. All non-expendable items not returned will be billed to the Customer at replacement cost or $50.00, whichever is greater. If accessories are an integral working part of the equipment, rental will not stop until said accessories are returned or replaced.

EXCUSABLE DELAYS

Delivery dates are approximate. GE shall not be liable for delays in delivery due to causes beyond its reasonable control, including but not limited to inability to obtain necessary materials, components, services or facilities. In the event of delay, the date of shipment shall be extended for a period equal to the time lost by reason of the delay.

EXPENDABLES

In those cases where certain items required for the proper operation of the equipment are expendables (such as charts, ink, etc.), GE will supply only such items as are initially shipped by the manufacturer.

SOFTWARE

If any software is supplied with the rented equipment, title to all such software (including programs and documentation) shall be retained by the software owner or by GE, and shall not be transferred to Customer. Customer is supplied the use of such software only for the rental term. Such software shall be used only on the specific equipment with which it was rented.

Customer shall comply with any restrictions set forth in the program license agreement, accompanying copyright notices, or other documentation on the use of such software. Customer shall not copy or duplicate, or permit anyone else to copy or duplicate, in any manner, any physical or magnetic version of any software provided hereunder, nor shall Customer copy or duplicate any printed materials related to and furnished with software.

Upon expiration or termination of the rental term, Customer shall return to GE the originally supplied software, all copies thereof, and all printed materials furnished by GE with such software. No licenses or rights of any kind are granted to Customer, except as may be set forth herein or in the applicable manufacturer's software of program license agreement.

Prior to the return of equipment to GE, Customer should erase or delete any information, data and software contained in it as GE assumes no obligation to do so.

PAYMENT

Payment is due NET upon receipt of invoice. Rates start on the date of shipment from our facilities and end upon our receipt of the rented equipment at the designated GE Rental/Lease return location. Rental periods in excess of fourteen (14) days will be billed in advance.

No purchase option or sale to Customer of equipment rented hereunder becomes effective until and unless Customer has made all required rental and associated rental expense payments to GE.

DEFAULT

In the event any invoice remains unpaid for a period of thirty (30) days or more after becoming due, or the Customer is otherwise in default or breach of the Terms and Conditions herein and fails to correct such breach within seven (7) days of notice thereof, GE may retake possession of the rented equipment with or without process of law and without demand or further notice.

Notwithstanding any requirements of notice of default provided above, in the event a petition under the federal bankruptcy laws is filed by or against the Customer, or the Customer makes an assignment for the benefit of creditors, or a receiver for the Customer is appointed or applied for, or the Customer ceases to function as a going concern, GE may declare the Customer to be in default and immediately take possession of the equipment and exercise any other remedies or rights that GE may have at law or in equity.

Repossession does not abate Customer's obligation to pay rent through the date of repossession. The costs of repossession, including reasonable attorney fees, shall be paid by Customer.

CUSTOMER'S OBLIGATIONS

The Customer shall not repair, modify or disassemble the rented equipment without prior written authorization of GE. **The Customer assumes and shall be fully responsible for any loss of, or damage to, the equipment from any cause whatsoever.** If any rented equipment is not returned, the Customer shall pay replacement costs, in addition to any rental payments due through the date of payment of the replacement cost. The Customer shall pay repair charges for any equipment returned in damaged condition.

EXCLUSION OF GOVERNMENT FLOW-DOWN PROVISIONS

GE considers that any services delivered have been selected by the Purchaser on the basis of adequate price competition. Accordingly, all clauses associated with cost or pricing data submittal, price reduction for defective cost or pricing data, cost accounting standards and disclosure and consistency of cost accounting standards are excluded from all transactions pursuant to this Agreement.

Any Licensed Program supplied hereunder is "Commercial Computer Software-Restricted Rights" as defined in the U.S. Government use, duplication or disclosure as set forth in the FAR Clause 52.227.19.

WARRANTY

Should the equipment fail to properly operate during the rental period through no fault of the Customer and the Customer notifies GE within two (2) days of the failure, GE will, at its option, either repair the equipment or supply replacement equipment subject to availability. This warranty does not apply if the product has been damaged by accident, abuse, misuse or misapplication, or as a result of service or modification by someone other than GE.

The foregoing warranty is exclusive and in lieu of all other warranties, **whether written, oral, implied or statutory. Unless otherwise expressly agreed in writing, GE does not warrant the merchantability of the components or equipment rented, or its fitness or suitability for any specific application or use,** nor shall GE be liable for any loss of damage whatever by reason of its failure to discover, report, repair or modify latent defects or defects inherent in the design of the equipment or software.

The foregoing shall constitute the sole remedy of the Customer and the sole liability of GE.

LIMITATION OF LIABILITY

In no event, whether as a result of breach of contract, warranty, tort (including negligence), or otherwise shall GE or its suppliers be liable for any consequential, incidental, or exemplary damages including, but not limited to loss of profit or revenues, loss of use of the products or any associated equipment, damage to associated equipment, cost of substituted products, facilities, services or replacement power, downtime costs, lost data, or claims of the Customer's customer for such damages.

Excluding claims for personal injury or death, GE's liability on any claim of any kind (including negligence) for any loss of damage arising out of or resulting from the equipment or rental service furnished hereunder shall in no case exceed the contract rental price of the specific equipment giving rise to the claim.

GENERAL

The validity, performance and all matters relating to the interpretation and effect of these Terms and Conditions and any amendments or revisions hereto shall be governed by the laws of the State of New York.

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